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Evaluation of the location choice of software industry in Istanbul based on the types of economy

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Abstract
One of the main fields of economic growth in developing countries is the software industry, which is one of the innovative industries. Istanbul has a great potential for software creation with its artistic potential, its unique cultural heritage, social networks, and engagement. The purpose of this article is to explore the clustering pattern of Istanbul's software industry and the choice of location from a spatial perspective, based on the types of economy. Three important conclusions have been reached by studying the spatial activity trends of the industry. Results include: (i) the software industry has a polycentric cluster pattern in the historical city center axis, (ii) a seat for the technological parks of particularly prestigious Universities in the center, and (iii) a chosen location in the center of town to benefit from the artistic industry. The results of this study will be a guide to the potential that will lead to the creative economy's growth in Istanbul's future plans.

Keywords
Creative economy, Software industry, Istanbul.

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1. Introduction

With the creative industries as the main economic growth sectors over the past twenty years, the emphasis has been on academic research as well as on public policy. The fact that information itself generates surplus value and that individuals establish their creative values in relation to their social structure has contributed to the development of a creative economy in the process of passing from the manufacturing sector to the information industry. The globalization of the world has a positive impact in metropolitan areas, while integrating with concepts such as innovative economic cultural diversity, human mobility, mobile information, corporate delivery, and mobile enterprise. These industries offer creative and original urban climate unlike other industries, create new jobs, enhance the city's image, and attract new urban possibilities (Enlil et al., 2011, 167).

Istanbul has major potential for the growth of these industries in terms of geographical place, cultural diversity, historical ruins, and urban vitality. These features make Istanbul a sector-based metric, an indicator where everyone in a broad spectrum measures their output, from production to consumption, in a creative sector; as Istanbul is geography that accumulates resources, new ideas are born, and production roots (Enlil & Evren, 2010).

The purpose of this article is to analyze the final structure, trends, and development of the software industry, which is seen as a creative industry defined as the economic development tool of Turkey, and to understand the potential and problems of spatial behaviors in Istanbul. In this context, the article makes two contributions to the literature findings on the software industry. First, to analyze the spatial distributions of software companies with a large data set using some of the latest modeling approaches for location, second to examine the urban services that the industry inevitably needs at a micro-level by determining the factors that affect the location behavior of the industry according to the types of economy.

In the next section, literature review is given for the purpose of this study. Chapter 3 presents the spatial econometric characteristics of software companies and the methodology of data used in forecasting. In Chapter 4, the estimation results are presented and discussed together with the characteristics of the study area. Section 5 concludes the article, summarizes the main contributions of this study, and makes recommendations for future research.

2. Evalution of location choice criteria of creative industries

Literature on factors determining the location choice criteria of industries such as agglomeration economies, human capital, taxes, wages has increased in recent years. In the literature, two approaches are often used regarding location selection modeling and criteria. The first focuses on the selection behavior of firms, and the second on the perspective of the region in which firms will be positioned (Arauzo-Carod, 2013). Among the empirical studies on the geography of creative industries, the most emphasized determinants are: firm size, industry concentration, local employment, industrial share, such as transportation and trade costs, 'location economies', industrial diversity, the market, the share of services, population density, social capital and links with different industries, etc. covering the 'urban economies' which implies cultural and artistic amenities 3T of Florida and finally, the foreign population with foreign labour 'Tolerance', population with higher education levels, qualified skilled labour, high-skilled jobs 'Talent/human capacity', R & D investments, the presence of Technology Parks, patented products, high-tech companies and concentration of technology-oriented occupations with employment density 'Technology (Cruz & Teixeira, 2014, 3-4).

2.1. Localization and urbanization economies

The location economy, which was defined by Marshall in 1890, is of great importance with its industrial concentration externalities, low costs, increasing income by scale, labor market and rapid access to and sharing local information (Marshall, 2013).

There are two types of economies represented as external scale economies. These are local economies and

urbanization economies. "Economies of localization" are defined as many different independent firms located close to each other in the same sector. "Economies of urbanization", on the other hand, are mainly defined as the maximum benefit from the diversification of industries and/or the choice of location by different industries (Meyer, 2000). The advantages of urbanization economies arise in metropolitan areas with large functional characteristics (UN-HABITAT, 2011, 3). The existence of these advantages also explains the clustering of the population and firms. Therefore, creative industries can cluster to benefit from the existence of a skilled labor market, specialized local suppliers of other creativity-fueled sectors, and local knowledge sharing (Lazaretti et al., 2009, 5).

A lot of research has been done on this subject in the last two decades. In recent field studies, it has been observed that localization and urbanization economies generally have positive effects on the location preferences of companies operating in creative industries. Localization economies and related determinants of urban externalities have a statistically positive effect on firms' location decisions (Cruz & Teixeira, 2014, 5). In the study of Lazaretti et al., the clustering patterns of creative industries in large and medium-sized cities in France and Italy based on economic geography and urban economy, and the cluster pattern of creative labor has been comparatively analyzed. In both countries, three cluster patterns, the structure of the industry/scale, localization economies, and urbanization economies (Lazaretti et al., 2009), had shown to have a positive impact. In the study of Lazaretti et al., It was found that the creative industries in the two countries have different characteristics. Creative industries in Italy mostly centered on cultural and artistic activities. And these activities have been supported by local economies and have a dispersed spatial pattern in the region. In Spain, on the other hand, creative industries are concentrated in large metropolitan areas to benefit from localization economies as well as from urbanization economies (Lazaretti et al., 2009).

Cruz and Teixeira (2014) have been researching the factors that decide the creative industry's spatial position in Portugal. The study examined the positive and important influence of localization economies on location determination and the positive effect of the urbanization economies, human resources, tolerance, and technology factors. Currid and Williams (2010) used GIS mapping techniques with zip code level data to examine the spatial clustering pattern of cultural industries. They concluded that cultural industries tend to cluster in highly concentrated areas such as Manhattan city center, Beverly Hills, and Santa Monica. In the study by Florida et al., 297 U.S.A. Although they only made a statistical analysis for the metropolitan city at the metropolitan level, they analyzed that the types of creative industries that complement each other have cluster patterns in similar areas (Florida et al., 2009; Kolenda & Yang Liu, 2012, 5). Enlil, Evren, and Dinçer (2011) analyzed that the cultural industries in Istanbul are clustered in the historical city center, the modern city center, and the sub-center developing around it. They defined the spatial distribution of this cluster pattern as the "culture triangle".

Although localization and urbanization economies are the first steps for the development of many industries, they are not a sufficient phenomenon for their innovation process and growth. In particular, the condition that the hi-tech industry can take place in the global market is based on integrating knowledge. Asheim (2007) examined the types of knowledge required for firms' innovation on three bases. Analytical knowledge base is primarily concerned with scientific knowledge aimed at understanding and explaining empirical facts. That is know-why. Synthetic knowledge base is applied to existing knowledge and is aimed at practical solving and designing problems. That is know-how. Symbolic knowledge base is a variety of economic forms of the aesthetic, culture-oriented content, designs, and images of products. That is 'everyday culture' (Asheim, 2007, 226). Innovation and design-oriented creative

industries that recreate an existing product or knowledge with new ideas and images feed on this knowledge.

For the globalization of industries, spatial proximity, often included in the literature, also requires non-spatial factors to ensure the learning and dissemination of the above-mentioned types of information (Mattes, 2011). Boschma (2005) stated that geographical proximity in knowledge transfer and learning processes is not an adequate factor in explaining their relations with their partners in remote locations, argued that firms need four more different types of proximity. These are organizational, institutional, social, and cognitive proximity. Cognitive dimension is associated with the essence of knowledge. If it is too much proximity, the learning process is fast and limited. If it is too little proximity, information that needs to be transmitted between actors can also cause misunderstandings and inaccuracies (Nooteboom, 1999). Social proximity is concerned with the effects of actors' social ties on the economy, such as family, friends, ex-collaborations (Boschma, 2005). Institutional proximity refers to the sharing of norms, practices within the identical social ecosystem, such as the institute, industry, academia, or government located in the same region. Organizational dimension refers to the proximity of knowledge shared by different departments of the same firm or membership in the same organizational institution (Davids & Frenken, 2017).

Weterings and Boschma, in a study with 256 software firms located in the Netherlands, analyzed that spatial proximity has a more dynamic structure than assumed interaction between young firms, but old firms are more prone to organizational and institutional proximity than spatial proximity (Weterings & Boschma, 2009). In research conducted by Broekel and Boschma (2016) with 372 companies from different industries and European countries, the relationship between dissimilar types of proximities of firms was investigated. The findings showed that more than %50 of firms have a relationship between cognitive and spatial proximity. They emphasized that most of the firms that exhibit the exact behavior consist of small companies and benefit from regional clustering. Furthermore, the findings stated that spatial proximity also helps firms to develop social proximity and institutional proximity (Broekel & Boschma, 2016). The literature and field studies show that small companies primarily share knowledge on a local scale with spatial proximity, whereas old firms focus more on institutional proximity. It is seen that spatial proximity has a positive impact on information sharing, interactive and dynamic learning processes for small companies, while it causes an adverse effect for old and international companies.

As in many conventional manufacturing industries, industries that develop technology also enjoy clustering advantages. So is the software industry that underlies the technology more spatially dispersed or more clustered over time? Isaksen (2004) analyzed that in his study involving 64 software companies in Oslo, the software industry exhibits an information-based cluster pattern in big cities. Maine et al. (2008), by examining the cluster pattern of 457 firms based on new technology, concluded that they benefit from clustering potential but have a more heterogeneous spatial distribution. They also stated that the software sector included in the study has positive effects on the growth of companies when they are located in various economic fields. Finally, while there are studies that high-tech manufacturing has spatially fewer densities, it seems that high-tech services strongly exhibit spatial accumulation processes (De Vol, 2009, 9).

Based on the definitions made, while the clusters in some industries of urban centers nurture the localization economy, the urbanization economy tries to provide all these clusters with the best climate, especially metropolitan areas and mega-cities. According to empirical studies on the choice of location of creative industries, it is expected that the localization economies, and especially the urbanization economies, will have a significant impact on the spatial behavior patterns of creative industries. Because innovation and creative processes are strongly connected

with the urban environment (Florida, 2002). Based on the definitions made, while the clusters in some industries of urban centers nurture the localization economy, the urbanization economy tries to provide all these clusters with the best climate, especially metropolitan areas and mega-cities.

2.2. Creative economy and software industry

Creative industries are defined as activities with the potential to create jobs and wealth based on creativity, individual talent, skills, and intellectual property rights (DCMS, 1998). In this context, creative industries Visual Arts, Performing Arts, traditional cultural products such as music and literature as well as creative talent and skill that requires the production of multimedia, software, video games, design, and contemporary architecture, such as 'content' covers production activities(O'connor, 2002). These activities have been around for a long time, but only at the end of the 20th century they were gathered under one category (Tomczak & Stachowiak, 2014, 7).

Since the definition and content of creative industries are handled in different dimensions from country to country, studies on their spatial distribution and economic effects are generally associated with the policies adopted by countries in the literature. However, there are four general approaches to creative industries in the literature (ESSnet-Cultute, 2012). The first approach was made by Hawkins, who stated that the development of digital technologies and the phenomenon of creativity divide the world. But with this division, Hawkins emphasized skills that express creativity through marketable products, not people's creativity (Levickaite, 2011, s744). According to Hawkins, creative industries are the core of the creative economy and are considered 'just another industry' (Hawkins, 2007; Moree, 2013, 744).

Hawkins has defined creative industries in 15 sectors. The software industry is among these sectors. The second approach is made by Florida (2002), who approaches the creative industries as a certain class, and defined the industries as "creative class". The creative class, more precisely, consists of people working in the science and engineering, architecture and design, education, science, music and entertainment sectors, whose economic function is to create new ideas, technology or creative content (Florida, 2002). Florida's theory differs from other creative industry theories. Because Florida argues that investigative talent drives economic growth. His economic growth theory consists of 3T, technology, talent and tolerance. He takes his theory one step further by adding the concept of tolerance to attract the necessary human resources needed by cities (Levickaite, 2011, 87).

The third approach is about the 'creative city'. Landry (2000) argues that only people are the most important resource for cities. According to Landry (2020), the purpose of big cities is clear, and those cities know where they are going. So for these cities, they have hardware that refers to physical structures such as streets, buildings and parks, software that refers to activities such as cultural life or shopping experiences, and 'orgware' that refers to how they are organized and managed.

The fourth approach is accepting creative economy as part of a broader economic system and supporting the new economy through the clustering of employees, firms, institutions, infrastructures, communication channels, and other active components (Moore, 2014; Scott, 2006). These approaches reveal that creative industries cannot be simply defined. Creative industries accommodate many components in cities with a wide variety of forms and applications, including creative networks, creative places, creative connections. But, rather than all the components, the main factors of the excessively rapid growth of creative industry types almost everywhere in the world are due to the fact that they are directly linked to technology and the economy. The combination of the digital revolution and economic environments has revealed many conditions necessary for the growth and development of the new economy (Levickaite, 2011, 91).

The advanced technology services that emerged with the digital revolution have been proven by many scientists to be of great importance for the

development of creative industries and other sectors. In advanced technology services, solid business costs become less important for the growth and maintenance of technology clusters in metropolitan economies, while locations with high access to information play a vital role in determining the economic success of regions (Vol et al., 2009, 9). Since no one knows how information and communication technologies will affect the way people and companies use spaces, much of the scientific and popular research on the subject is based on more theoretical, anecdotal, and speculation, and less careful empirical analysis (De-Michelis, 1996).

But the spatial practices of these technologies are quite important. Because they offer the opportunity to perform much more economic operations remotely quickly, from home employee to head office employee, consumer to store, from one company to another, they can decrease the necessities of people and industries to cluster in metropolitan cities (Atkinson, 1998, 134).

Many factors of traditional location factors, which have always been attractive to industries, are also important for high-tech industries. But along with these factors, factors such as access to qualified labor, proximity to educational facilities and research institutions, connections with existing complementary sectors, venture capital, competitive environment, climate, other quality-of-life factors, and overall cost of living seem to be the most supporting location decisions for high-tech industries (De Vol et all., 2009, 4).

The software industry, which forms the core of high technology, it is seen as an opportunity to support the economic growth and development of developing countries (Nicholson & Sahay, 2008). The software connects different sectors; it creates an interface that offers transitive between them. This dynamic is an important opportunity for creative industries, which is a vital requirement to engage with the rest of the economy (Enlil et all., 2015, 32). The advantage of the software industry, the engine of significant economic growth and development, provides sufficient evidence with its examples in the cases of India and Ireland (Baraya et.all., 2008). Therefore, this study will examine the clustering pattern of the software industry and the location choice preferences of the industry based on the economy types in Istanbul, which is one of the mega-cities of Turkey.

3. The methodology of the research

The data sets of this study consist of the software firms that are actively seen in the Turkey Software Industry Association. Face-to-face surveys were conducted between 10.09.2019 and 30.10.2019 with all 177 companies registered with the association and operating in Istanbul (Köse, 2019). The interviews were held with company founders, senior executives, or managers, and they were asked different questions about the company other than location selection criteria. After creating the data set, the Exploratory Spatial Data Analysis method (ESDA), which is frequently used in regional studies, and the AHP (Analytic Hierarchy Process) method, which is used to determine the location selection criteria of the companies, were deemed appropriate for the analysis of the spatial data analysis of the research.

ESDA includes techniques used to visualize and explain spatial distributions, discover the pattern of spatial clustering, and identify outliers (Anselin, 1998, 258). Various methods of ESDA help in revealing possible clustering tendencies of the data in the pre-modeling phase of empirical research (Varga, 1998, 27). In addition to clustering tendencies, ESDA includes defining data characteristics and formulating hypotheses from the data (Haining, 2003, 5). Therefore, "the Global Moran's I" analysis and "Local Moran's I" analysis were applied in the first stage of this study.

The Global Moran's I statistic is expressed as (Rey & Montouri, 1999):,

$$I_t = \left(\frac{n}{s_o}\right)\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}x_{i,t}x_{j,t}}{\sum_{i=1}^{n}\sum_{j=1}^{n} x_{i,t}x_{j,t}},$$

where i and i are neighbors, W is a standardized spatial weight matrix. w_{ij} If i and j are neighbors, it takes a value of 1, otherwise it takes a value of 0. $x_{i,t}$ Besides, is the number of

software firms in t, n is the number of neighbors, and s_o is the sum of all w_{ij} (Rey & Montouri, 1999).

Test statistics were applied to all provinces to better explain the spatial coralization properties of the software firms, including whether local Moran's I test firms differ from the surrounding provinces. Local Moran's I test is as follows:

$$I_{i,t} = \left(\frac{x_i}{m_o}\right) \sum_{j=1}^{n} w_{i,j} x_{i,t},$$

with

$$m_o = \sum_i^n x_{i,t}^2$$

In addition to the Global Moran's I expression, m_o is equal to the sum of the elements of w_{ij} (Rey & Montouri, 1999).

The more similarity of data in locations close to each other than distant data reveals the dependency structure. The application of classical statistical theory to these data causes problems (Haining, 2003, 16). In the first part, after analyzing the spatial clustering styles of software firms, factors affecting the location selection criteria of firms based on literature research were determined and these factors were examined using the AHP method. AHP method was developed by Thomas L. Saaty in 1977 for the solution of complex multi-criteria decision-making problems. In order to solve the problem with AHP, the following steps should be taken:

Step 1: The decision-making problem is defined.

The definition of the decision-making problem consists of two stages. In the first stage, decision points are determined. In the second stage, factors affecting decision points are determined. In this study, the number of decision points is symbolized by m and the number of factors affecting decision points with n.

Step 2: The binary comparison matrix is created.

The comparison matrix between factors is a dimensional square matrix. The matrix components on the diagonal of this matrix take the value 1. The comparison matrix is shown below.

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} = 1/a_{12} & 1 & \dots & a_{2n} \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ a_{n1} = 1/a_{1n} & a_{n2} = 1/a_{2n} & \dots & 1 \end{bmatrix}$$

a is the binary comparison value of i criterion and j criterion, and the aji value is obtained from 1 / aij. This feature is called reciprocity. aij value is the answer to the question, "How much should the criterion i value be preferred over another criterion j?". Decision options are compared separately according to each criterion. Decision matrices are constructed using the comparison scale 1-9 suggested by Saaty below.

Table 1. *The significance scale of the comparison matrix.*

Intensity of Importance	Definition	Explanation
1	Same	Neither of the two alternatives is preferable over the other
3	Weak	One alternative is preferred slightly over the other
5	Clear	One alternative is preferred clearly over the other
7	Strong	One alternative is preferred strongly over the other
9	Very Strong	One alternative is preferred very strongly over the other
2.4.6.8	Compromise	Can be used for graduation between evaluation
Reciprocals of above	If activity i has one of the above nonzero number assigned to it when compared with activity j, then j has the reciprocal value when compared with i	A comparison mandated by choosing the smaller elemet as the unit to estimate the larger one as a multiple of that unit

Step 3: Binary comparison matrices are normalized.

Each element in the matrix is normalized by dividing it by its column sum. Each column sum of the normalized matrix is 1. The following equation is used.

$$a_{ij}' = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}, \quad i,j = 1,2,\dots,n$$

Step 4: The priority vector is calculated.

Each row sum of the normalized matrix is divided by the size of the matrix and averaged. These values are the weight of significance calculated for each criterion. These weights form the priority vector. The following equation is used. Thus, percentage significance distributions showing the relative importance values of the criteria are obtained.

$$w_i = \left(\frac{1}{n}\right)\sum_{i=1}^{n} a_{ij}' \quad , \quad i,j = 1,2,\ldots,n$$

Step 5: The consistency rate is calculated.

After the paired comparisons and determination of their priorities, the consistency of the comparison matrices is calculated. In order to determine whether an A matrix formed as a result of binary comparison judgment is consistent or not, it is necessary to calculate the coefficient called "Consistency Index (CI)". The CI coefficient is as follows:

$$CI = \frac{\lambda_{max} - n}{n-1}$$

Formula equality is calculated. The formula is

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{\sum_{j=1}^{n} a_{ij} w_j}{w_i}\right)$$

In order to evaluate the consistency, the value of "Random Index (RI)" should be known. RI values defined for n-dimensional comparison matrices are given in Table 2.

Table 2. *Random Index_RI.*

n	RI
1	0
2	0
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49
11	1.51
12	1.53
13	1.56
14	1.57
15	1.59

After the CI and RI values are determined, the "Consistency Ratio (CR)" is calculated.

$$CR = \frac{CI}{RI}$$

If the CR is less than 0.10, it is decided that the comparison matrix is consistent.

Step 6: The decision options are listed.

All priorities matrix is obtained by combining the priority vectors obtained for the criteria. The resulting vector is obtained by multiplying the priority vector of the decision options with the all priorities matrix. The decision option with the highest weight in this vector is determined as the decision option to be preferred for the solution of the problem.

4. The potential of the software industry in Istanbul

Turkey is the world's 17th largest economy and Istanbul represents almost one-quarter of the economy (Enlil & Evren, 2010, 38). Istanbul is Turkey's most popular city for creative industries with its urban appeal, population diversity, cultural and historical heritage. As innovation centers in the city, it strongly supports the clustering of creative industries within the city with its advanced technological infrastructure and technoparks, contributing to the increase of creative workforce and international awareness Öztürk-Ekdi & Çıracı, 2015, 71).

The software industry is one of the main industries of development that can contribute to the creative economy of Istanbul in current planning strategies and policies. Examining the relationship between the software industry and the city, which is also emphasized in the plans and policies made on regional and provincial basis, and determining the potential of Istanbul in becoming a creative city has encouraged to work on this subject. The study will help to observe the current potentials and problems of the industry within the scope of the creative economy by examining the spatial behavior patterns of the software industry in Istanbul and determining the factors

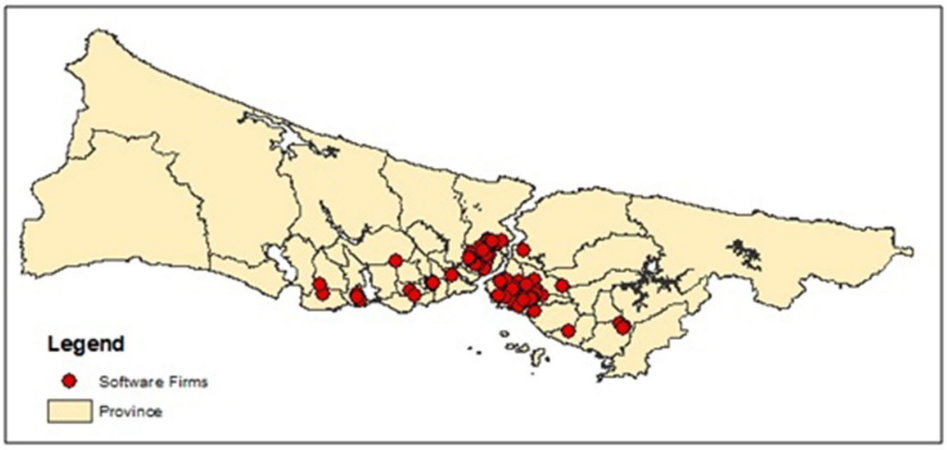

Figure 1. *Spatial distribution of YASAD member software companies in Istanbul, 2019.*

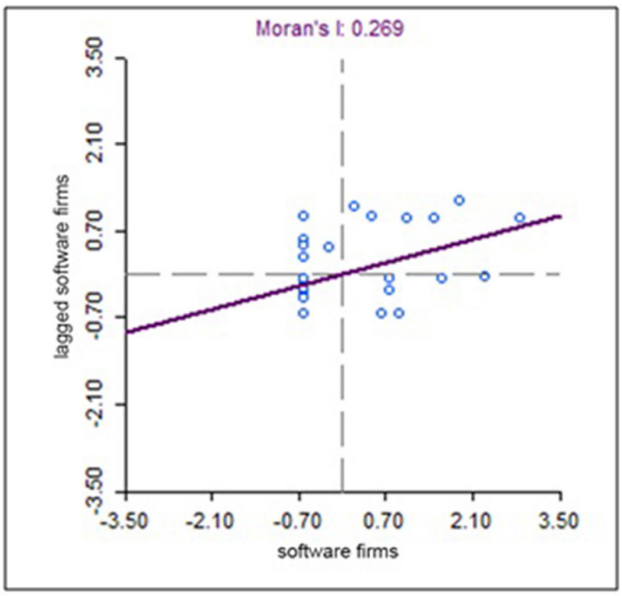

Figure 2. *Moran Scatter Diagram of the Number of Firms in Istanbul, 2020.*

affecting the location selection criteria. In this direction, firstly, the spatial cluster pattern and clustering regions of the industry were examined. In the second stage, factors affecting location selection criteria of firms based on the literature were determined. The potentials of these factors in the location of the software industry, in the urban and creative economy have been identified with the urban elements that affect the location selection.

The sample of the research consists of all software companies that are members of YASAD. Face-to-face interviews were held with 177 software companies registered with the association. As shown in Figure 1, 32 of the companies on the European Side are located in Maslak, 14 in Beşiktaş, 12 in Kağıthane, 5 in Beyoğlu, 11 in Esenler, 9 in Avcılar and 28 in different districts. On the Anatolian side, 10 of the companies have chosen locations in different districts, including 21 in Ataşehir, 12 in Kadıköy, 9 in Üsküdar, 7 in Maltepe and Pendik.

In Figure 2, it is observed that the numbers of firms are not randomly distributed in the Moran scatter diagram, but are concentrated in areas with positive autocorrelation. The Moran's I value, which is calculated as 0.269, indicates that the distribution of software companies in Istanbul has positive spatial autocorrelation.

In order to examine the meaningful spatial clustering or scattered place selection pattern in the districts within the city and to examine the neighborhood relations of the observation values whose distribution is handled with the Moran's I diagram, the local indicator LISA analysis of the spatial relationship was used.

In the LISA map expressed in Figure 3, districts in the HH region, expressed in red, represent the districts with the highest clustering of the industry. It is observed that these districts chose places intensely in Maslak, Beşiktaş and Kâğıthane districts, which are included in the central business area of Istanbul, and in the sub-center Ataşehir district, which is designed as the financial center of Istanbul. In addition, it is observed that the districts in the city center are affected by the neighborhood relations. The HL region, on the other hand, refers to the districts with higher clustering potential but lower neighborhood relations compared to the HH region. These are Esenler

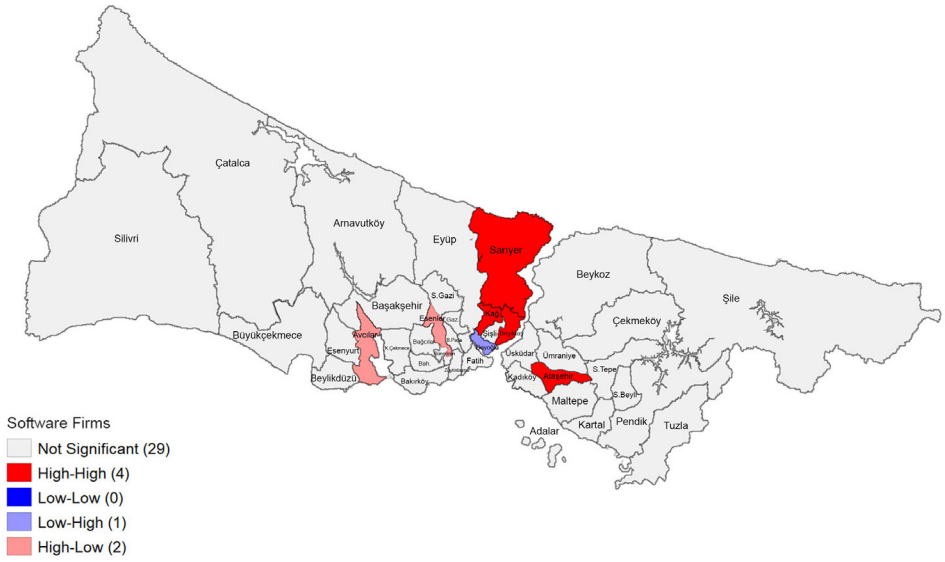

Figure 3. *LISA map of the number of companies in Istanbul, 2020.*

and Avcılar districts. Beyoğlu district, which has the status of a historical city center in the LH region, states that its clustering potential is low, but its environment has a high spatial clustering.

After examining the spatial clusters of the software industry according to districts in Istanbul, the dynamics affecting the location of the industry are tried to be revealed by spatial analysis methods. In this direction, it was aimed to determine the factors affecting the location selection of the companies as well as the research of the spatial cluster. For this purpose, similar studies in domestic and foreign literature were examined. Using the dynamics in the literature, 3 main criteria affecting the location preferences of the companies, and the sub-criteria of these main criteria were determined. Firstly, the consistency ratio (CR) was calculated as 0.062 as a result of paired comparisons for the main criteria. This value is proof that the weights calculated according to the formula mentioned in Table 2 are reliable. Paired comparisons for the main criteria are given in Table 3.

When the location selection criteria of the firms are evaluated according to the types of economy, it has been observed that "Creative Economy" (0,723) is by far the most important factor among other types of economy. The second important element following the Creative economy is "Urbanization Economies" (0.193) and lastly "Localization Economies" (0.083). After the comparison of the main criteria, sub-criteria were compared according to Florida's 3T, which was determined as the main criteria of the creative economy. As a result of the binary comparison of these criteria, the weights have been proven to be reliable with a consistency ratio (CR) of 0.06. The comparison table is given in Table 4.

The main criteria of the creative economy have been determined according to Florida's 3T and are examined in more detail in sub-criteria in these criteria. According to Table 5, the factor affecting the creative economy the most was Talent (0,643), second place was taken by Technology (0,282) and finally Tolerance (0,073). After comparing the main criteria, the weights and compliance rates of 15 sub-criteria were tested in the last stage. Table 5 shows the weights of all main criteria and the weights and rates of compliance of their sub-criteria.

The findings of the research proved that the important type of economy for company officials is the creative economy. Among the 3 main criteria considered within the creative economy, it has been observed that Talent / Human Capital is in the first place, Technology is in the second and Tolerance is in the last place. In the location selection criteria of the companies, they tend to choose places that meet the investment criteria of high-tech companies, the level of science and technology development, and special R&D, especially with access to a qualified workforce,

Table 3. *Paired comparisons matrix and weight values created for the main criterion.*

Main Criteria	Creative Economy	Urbanization Economies	Localication Economies	Weight
Creative Economy	1.00	5.00	7.00	0,723
Urbanization Economies	0.20	1.00	3.00	0,193
Localicaition Economies	0.14	0.33	1.00	0,083
Consistency Ratio (CR)	0,062			

Table 4. *Pairwise comparison matrix and weight values for the main criteria of the creative economy.*

Main Criteria	Talent	Technology	Tolerance	Weight
Talent	1.00	3.00	7.00	0,643
Technology	0.33	1.00	5.00	0,282
Tolerance	0.14	0.20	1.00	0,073
Consistency Ratio (CR)	0,06			

Table 5. *Weight values of all criteria affecting software companies' location selection criteria according to location factors.*

Main Criteria	Sub-criteria		Weight	CR
CREATIVE ECONOMY (0,723)	Talent/ Human Capital (0,643)	Access to a qualified workforce	0,602	0,025
		Openness to new ideas/difference	0,290	
		High focus on talent	0,108	
	Technology (0,282)	The density of high-tech firms	0,433	0,045
		Level of science and technology development	0,317	
		Province's Private R&D investment	0,250	
	Tolerance (0,073)	City's unique cultural amenities and museums	0,600	0,063
		Foreign workforce working in the software industry	0,400	
URBANIZATION ECONOMIES (0,193)		Coexistence with complementary sectors	0,565	0,069
		Proximity to the labor market	0,235	
		Customer potential	0,105	
		Being in a prestigious neighborhood	0,095	
LOCALICATION ECONOMIES (0,083)		Coexistence with the same sectors	0,484	0,035
		Easily accessible location	0,426	
		Availability of land and rental values	0,090	

openness to new ideas, and high focus on talent. The fact that many software companies chose a place in the city center, sub-centers, and technoparks of prestigious universities close to the city center supports the findings of the research. Among the criteria in the creative economy, data based on tolerance are quite low in the creative economy. The fact that companies primarily need a qualified workforce and secondly focus on technological infrastructure services has reduced the importance of tolerance based criteria. This finding shows that most of the software companies have deficiencies in working at the local scale and in interactive learning, sharing information, and creating a creative environment with different international institutions or organizations.

The secondary factor considered in the location selection of companies is urbanization economies. Coexistence with complementary sectors in urbanization economies is as important as clustering in places with high-tech firms. In order to minimize risks and increase the probability of success, software companies try to exist in the free market mechanism by forming alliances with other sectors with complementary skills. Therefore, the findings support that firms tend to choose locations in the city center and sub-centers where complementary sectors are concentrated / clustered, rather than in the labor market, customer potential and prestigious districts.

The last factor taken into account in the choice of location of companies is localization economies. Coexistence with the same sectors in this element and being in an easily accessible location are of high importance and close to each other, while land and rental values are very low. The software industry, which requires intense information flow and strong communication, cares about being in an accessible place in order to provide qualified workforce, and benefits from location economies to keep the competition alive with other sector companies in regions with technological infrastructure. Although this element is evaluated in the last place, it is among the factors considered.

5. Evaluation and the results

The software industry, which is the core of digitalization, became a focus in almost every field around the world, and is also known as a high-tech industry, has become one of the main sectors that support the urban economy, especially in recent years. The increasing importance of the sector has formed the basis for this study to examine the spatial behavior patterns in

metropolitan Istanbul in the context of the urban economy. Our results strongly suggest that the city tends to cluster in the highly competitive central business districts (CBD) and benefit from urban economies.

In this study, the ESDA method was used to analyze the spatial clustering pattern of the software industry first, and then the AHP technique was used to determine the weights of the factors that are important in the choice of location according to the types of economy. The opinions of YASAD member companies included in the scope of the study were interviewed with the authorities, considering the critical characteristics that companies should have in order to be successful. The results of the research reflect the perspective of the company officials on the factors that are effective in the location selection decision of their companies.

In the study, the opinions of company officials were tested by statistical methods. The findings of the research show that the software industry, was made by determining location criteria of firms according to cluster pattern using ESDA method and economic types with AHP technique. However, since there are no similar studies on this subject, comparison with other studies cannot be made. Similar results have been obtained with the spatial studies on the software industry in the literature.

In their study, Mendez-Ortega and Arauzo-Carod (2019) examined the spatial distributions of the software and game industry in Hamburg, Lyon, and Barcelona cities using the near neighbor index (NNI), Kernel density, K-density functions and entropy index techniques and observed that they have different cluster patterns in metropolitan areas. This study, on the other hand, has reached the conclusion, based on Berköz and Türk's (2007) city center stratification study in Istanbul, that firms exhibit a polycentric cluster pattern in the sub-center covering Maslak, Beşiktaş, Kâğıthane, which develop around the traditional historical city center, and Ataşehir and Kadıköy districts on the other side of the city. When compared with the Mendez-Ortega and Arauzo-Carod study, it has been observed that Istanbul has similar spatial behavior patterns to Hamburg.

The study strongly indicates that the software industry is fueled by the creative economy through clustering. Among the location selection criteria of the sector, It has been observed that criteria such as qualified and equipped workforce, technological services, coexistence with the same sector and service provider sectors, and accessibility come to the fore, and although these criteria have been examined in separate economic activities, it should be noted that there are spatial criteria that affect each other and are dependent on each other. In other words, the central core of Istanbul not only supplies an urban environment for interactive learning and services but also provides a 'creative milieu' (Enlil et all, 2011, 181; Landry, 2006). Therefore, the reason why the software industry in Istanbul chooses a location close to the city center is to feed on the creativity of the city and the

Therefore, the reason why the software industry in Istanbul chooses a location close to the city center is that the industry's customers in the center, face-to-face relations with other sectors, advanced infrastructure and transportation systems, living labs, prestigious universities, and innovation centers benefit from a competitive environment that improves knowledge bases, learning process, innovation, and active productivity. In addition to all creative amenities, the software industry also is fed on the social and cultural capital of dense urban facilities such as museums, workshops, exhibition areas, heritage structures, touristic places, parks, local markets, squares, restaurants, and cafes to trigger individual creativity and reach the needed human capacity.

This study focuses on issues that will contribute to the socio-spatial development of the software industry, which is strategically important for Istanbul, with field-specific findings in a certain period of time. For the sustainability of the sector, it has been observed that the spatial pattern of the firms has positive effects on their economic types depending on their choice of location and it is clearly seen that the city has the potential to turn into "creative innovation clusters" in future scenarios.

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